

# ADT PLM

## Programmer's Learning Machine

Matthieu Nicolas

IJD Seminar, 2016-02-02

## 1 Presentation of PLM

- Purposes
- Demo
- About PLM
- Architecture

## 2 To a web app

- Goals
- PLM as a library
- Outcome

## 3 Assessment of user's code

- Challenges
- Extraction of the execution component
- Docker

## 4 Result

## 5 Next steps

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# Presentation of PLM

## Purposes

- Application to learn programming.

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- Application to learn programming.
- Allows students to progress at their own speed...

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- Application to learn programming.
- Allows students to progress at their own speed...
- ... while the teacher helps the ones having trouble.

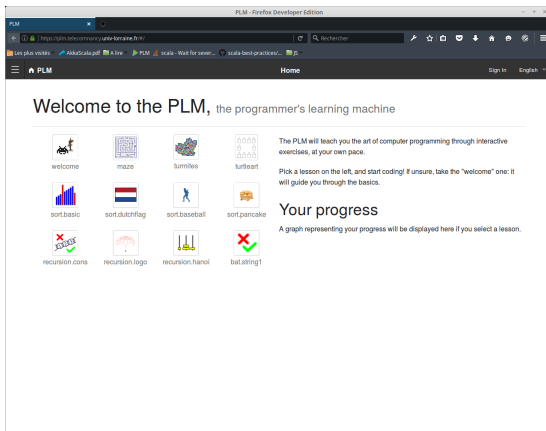
# Presentation of PLM

## Purposes

- Application to learn programming.
- Allows students to progress at their own speed...
- ... while the teacher helps the ones having trouble.
- Used at TELECOM Nancy since 2008.

# Presentation of PLM

## Quick demo



- Available at <https://plm.telecomnancy.univ-lorraine.fr>



# Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/la/lessons/maze/maze-wallfollower/maze-wallfollower-maze

PLM

Maze / WallFollowerMaze

Se connecter Java Français

World Objective



Éditeur de code:

Réinitialiser API

```
public void run() {  
    // ...  
}
```

Résultats de l'exécution

Cas de tests:

Another labyrinth Labyrinth

# Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/.../recursion/hanoi/hanoi.lessons/hanoi.Hanoi

Recherche

Les plus visités Linux Mint Community Forums Blog News NinjaMock - free tool... Spotify Web Player Wau The Most Amaz... Coursa P2P

PLM Recursion.hanoi / HanoiBoard Se connecter Java Français

World Objective

0 Move



Résultats de l'exécution

Cas de tests:

solve(0,1,2) solve(1,2,0) solve(2,0,1)

Éditeur de code: Réinitialiser API

```
public void hanoi(int height, int src, int other, int dest) {  
    ...  
}
```

# Presentation of PLM

12 lessons, 200 exercises

PLM - Mozilla Firefox

https://plm.univ-lorraine.fr/ta/lessons/recursion/logo/recursion/logo/tree.Tre

Les plus visités Linux Mint Community Forums Blog News NinjaMock - free tool... Spotify Web Player Wau The Most Amaz... Coursa P2P

PLM Recursion.logo / Tree Se connecter Java Français

World Objective



Résultats de l'exécution

Éditeur de code: Réinitialiser API

```
public void tree(int steps, double length, double angle, double shrink) {  
    // ...  
}
```

Cas de tests:

tree(10,100,90,0.68)	▶	tree(10,80,45,0.7)	▶
tree(7,75,15,0.8)	▶	tree(7,75,30,0.8)	▶

# Presentation of PLM

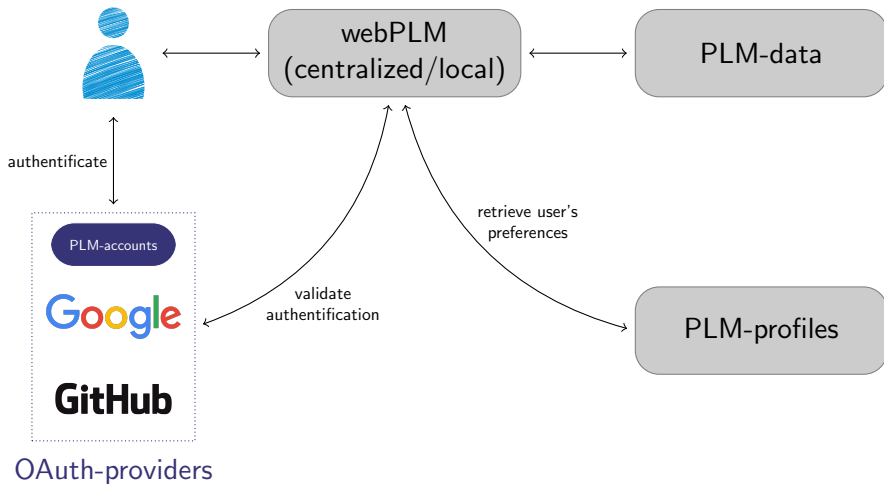
Languages and programming languages

- Available languages:
  - English
  - French
  - Brazilian Portuguese
- Supported programming languages:



# Presentation of PLM

## Application's architecture



# Outline

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# To a web app

## Evolution of the project

- Formerly a fat client
  - Written in Java

# To a web app

## Evolution of the project

- Formerly a fat client
  - Written in Java
- Switch to a web application
  - Server implemented in Scala using *PlayFramework*
  - User interface written in Javascript using *AngularJS* and *Foundation*





# To a web app

## Motivations

- More user-friendly
- Aim to setup SPOC<sup>1</sup> and MOOC<sup>2</sup>
- But don't have the time and means for a reboot

---

<sup>1</sup>Small Private Online Course

<sup>2</sup>Massive Open Online Course

# To a web app

## Refactoring PLM

- Implemented a headless version of PLM: *PLM-engine*
  - Provide all PLM's content and methods
  - But without a user interface

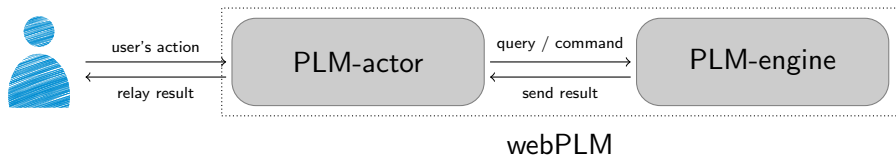
# To a web app

## Implementing the server

- Designed a communication protocol between the server and the client
  - User's actions sent to server as JSON messages
- Only need to implement an interpreter
  - Parse messages received from the client
  - Query or command PLM-engine according to the message
  - Send back result or acknowledgement to the client

# To a web app

Interactions between components



# To a web app

## Results

- Build quickly a web application from the fat client...
- ... but can't share common ressources among users

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# Assessment of user's code

## Limits

- Run on the same machine, same JVM

# Assessment of user's code

## Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
  - Infinite loops



# Assessment of user's code

## Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
  - Infinite loops
- And from more malicious "mistakes"?
  - Infinite thread creation
  - Endless file creation

# Assessment of user's code

## Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
  - Infinite loops
- And from more malicious "mistakes"?
  - Infinite thread creation
  - Endless file creation
- And from *System.exit(whatever)*?

# Assessment of user's code

## Limits

- Run on the same machine, same JVM
- How to protect ourselves from users' rookie mistakes?
  - Infinite loops
- And from more malicious "mistakes"?
  - Infinite thread creation
  - Endless file creation
- And from *System.exit(whatever)*?
- Scalability issues

# Assessment of user's code

Delegate execution to workers

- Called *Judges* in the litterature
- Use PLM-engine as well
- Workflow:
  - Retrieve an execution request
  - Parse the request to extract parameters
  - Configure PLM-engine according to them
  - Run the user's code
  - Send back result to webPLM

# Assessment of user's code

## Message queues

- Message-driven architecture
- Help to implement:
  - Producer/Consumer pattern
  - Request/Response pattern
- Different reliability patterns of the message processing:
  - Only one worker
  - At least one worker
  - All workers

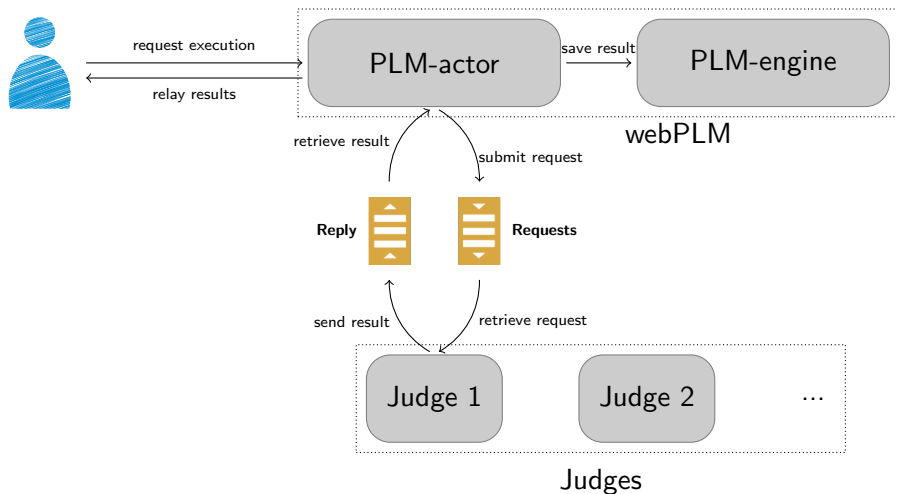
# Assessment of user's code

## Message queues

- Message-driven architecture
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  - Request/Response pattern
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# Assessment of user's code

## Architecture with judges



# Assessment of user's code

## Pros and cons

- Pros:
  - Allow to run code without impacting webPLM's performances
  - Meet the scalability requirements



# Assessment of user's code

## Pros and cons

- Pros:

- Allow to run code without impacting webPLM's performances
- Meet the scalability requirements

- Cons:

- Make sure to use the right version of PLM-engine
- Need to deploy them easily
- Should restart them after each execution
- Have to restrict their resources usage

# Assessment of user's code

## Docker

- Lightweight virtualization tool
- Build image of your application
- Run containers based on images



# Assessment of user's code

## Example of Dockerfile

- Dockerfiles describe how to set up the application

```
Dockerfile
1 FROM debian:jessie
2 MAINTAINER Gerald Oster <oster@loria.fr>
3
4 RUN apt-get update -y && apt-get upgrade -y && \
5     apt-get install --no-install-recommends -y -q apt-utils curl ca-certificates git unzip
6
7 RUN echo "deb http://ppa.launchpad.net/webupd8team/java/ubuntu trusty main" | tee /etc/apt/sources.list.d/webupd8team-java.list && \
8     echo "deb-src http://ppa.launchpad.net/webupd8team/java/ubuntu trusty main" | tee -a /etc/apt/sources.list.d/webupd8team-java.list && \
9     apt-key adv --keyserver keyserver.ubuntu.com --recv-keys EEA14886 && \
10    apt-get update -q && \
11    echo debconf shared/accepted-oracle-license-v1-1 select true | debconf-set-selections && \
12    echo debconf shared/accepted-oracle-license-v1-1 seen true | debconf-set-selections && \
13    apt-get install -y --force-yes oracle-java8-installer oracle-java8-set-default && \
14    apt-get clean && rm -rf /var/lib/apt/lists/* /tmp/* /var/tmp/* /var/cache/*
15 ENV JAVA_HOME /usr/lib/jvm/java-8-oracle
16
17 RUN curl -O http://downloads.typesafe.com/scala/2.11.7/scala-2.11.7.tgz && \
18     tar xvfz scala-2.11.7.tgz -C / && \
19     rm scala-2.11.7.tgz
20 ENV SCALA_HOME /scala-2.11.7
21 ENV PATH $PATH:$SCALA_HOME/bin
22
23 RUN mkdir /app
24
25 WORKDIR /app
26 EXPOSE 9000 9443
27
28 ADD ["target/universal/stage", "/app/webplm-dist"]
29
30 WORKDIR /app/webplm-dist
31 CMD ["bin/web-plm", "-Dhttps.port=9443", "-mem", "4096", "-J-server"]
32
```

- Run *docker build -t tag /path/to/Dockerfile* to build the image
- Start containers with *docker run tag*

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2 MAINTAINER Gerald Oster <oster@loria.fr>
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14    apt-get clean && rm -rf /var/lib/apt/lists/* /tmp/* /var/tmp/* /var/cache/*
15 ENV JAVA_HOME /usr/lib/jvm/java-8-oracle
16
17 RUN curl -O http://downloads.typesafe.com/scala/2.11.7/scala-2.11.7.tgz && \
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- Start containers with *docker run tag*

# Assessment of user's code

More about *docker run*

- Can also manage
  - Ports

# Assessment of user's code

More about *docker run*

- Can also manage
  - Ports
  - Volumes

# Assessment of user's code

More about *docker run*

- Can also manage
  - Ports
  - Volumes
  - Links between containers



# Assessment of user's code

More about *docker run*

- Can also manage
  - Ports
  - Volumes
  - Links between containers
  - Environment variables
  - Runtime constraints on resources
  - Restart policies
  - And a **lot more**

# Assessment of user's code

More about *docker run*

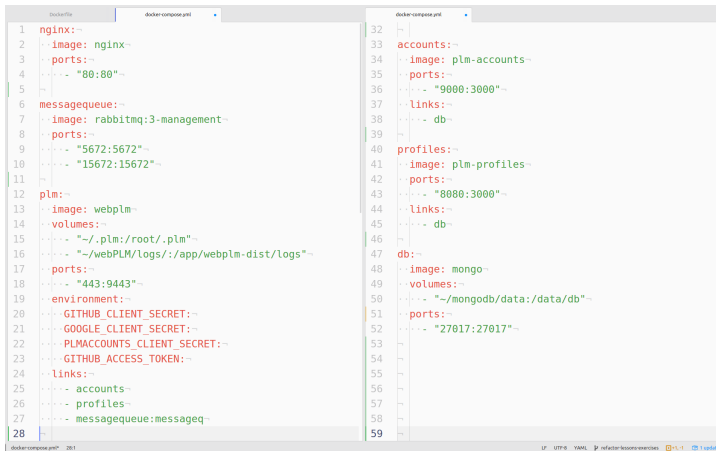
- Can also manage
  - Ports
  - Volumes
  - Links between containers
  - Environment variables
  - Runtime constraints on resources
  - Restart policies
  - And a **lot more**
- Commands can become quite complex

```
docker run -p 443:9443 -link plm-accounts:accounts -v  
~/webPLM/logs/:/app/webplm-dist/logs webPLM
```

# Assessment of user's code

## Docker-compose

- Tool to easily deploy multi-containers applications



```
1  nginx:~
2  ..image: nginx~
3  ..ports:~
4  ..- "80:80"~
5  ~
6  messagequeue:~
7  ..image: rabbitmq:3-management~
8  ..ports:~
9  ..- "5672:5672"~
10 ..- "15672:15672"~
11 ~
12 plm:~
13 ..image: webplm~
14 ..volumes:~
15 ..- "/.plm:/root/.plm"~
16 ..- "/webPLM/logs:/app/webplm-dist/logs"~
17 ..ports:~
18 ..- "443:9443"~
19 ..environment:~
20 ..- GITHUB_CLIENT_SECRET:~
21 ..- GOOGLE_CLIENT_SECRET:~
22 ..- PLMACCOUNTS_CLIENT_SECRET:~
23 ..- GITHUB_ACCESS_TOKEN:~
24 ..links:~
25 ..- accounts~
26 ..- profiles~
27 ..- messagequeue:messageq~
28 ~
32 accounts:~
33 ..image: plm-accounts~
34 ..ports:~
35 ..- "9000:3000"~
36 ..links:~
37 ..- db~
38 ~
39 ~
40 profiles:~
41 ..image: plm-profiles~
42 ..ports:~
43 ..- "8080:3000"~
44 ..links:~
45 ..- db~
46 ~
47 db:~
48 ..image: mongo~
49 ..volumes:~
50 ..- "/mongodb/data:/data/db"~
51 ..ports:~
52 ..- "27017:27017"~
53 ~
54 ~
55 ~
56 ~
57 ~
58 ~
59 ~
```

- Deploy environment with *docker-compose up*

```

1  nginx:~
2  ..image: nginx~
3  ..ports:~
4  .... - "80:80"~
5  ~
6  messagequeue:~
7  ..image: rabbitmq:3-management~
8  ..ports:~
9  .... - "5672:5672"~
10 .... - "15672:15672"~
11 ~
12 plm:~
13 ..image: webplm~
14 ..volumes:~
15 .... - "~/plm:/root/.plm"~
16 .... - "~/webPLM/logs/:/app/webplm-dist/logs"~
17 ..ports:~
18 .... - "443:9443"~
19 ..environment:~
20 .... GITHUB_CLIENT_SECRET:~
21 .... GOOGLE_CLIENT_SECRET:~
22 .... PLMACCOUNTS_CLIENT_SECRET:~
23 .... GITHUB_ACCESS_TOKEN:~
24 ..links:~
25 .... accounts~
26 .... profiles~
27 .... messagequeue:messageq~
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```

```

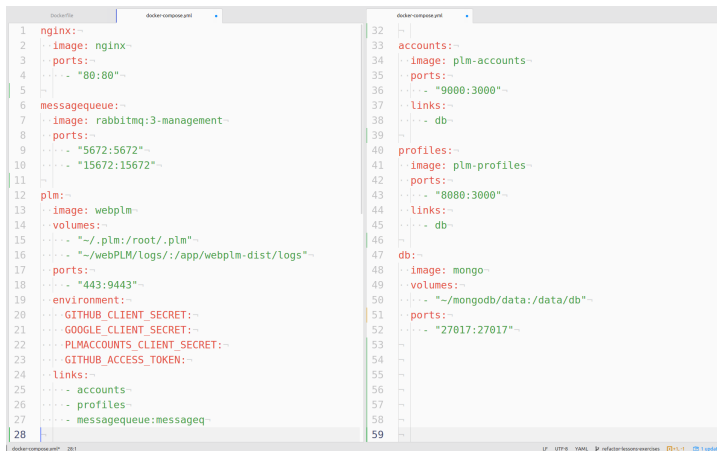
32 ~
33 accounts:~
34 ..image: plm-accounts~
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36 .... - "9000:3000"~
37 ..links:~
38 .... - db~
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40 profiles:~
41 ..image: plm-profiles~
42 ..ports:~
43 .... - "8080:3000"~
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45 .... - db~
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52 .... - "27017:27017"~
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55 ~
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```

# Assessment of user's code

## Docker-compose

- Tool to easily deploy multi-containers applications



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```

- Deploy environment with *docker-compose up*

# Assessment of user's code

## Docker in our case

- Deploy easily all components
- Restart judges automatically
- Limit users' mischiefs

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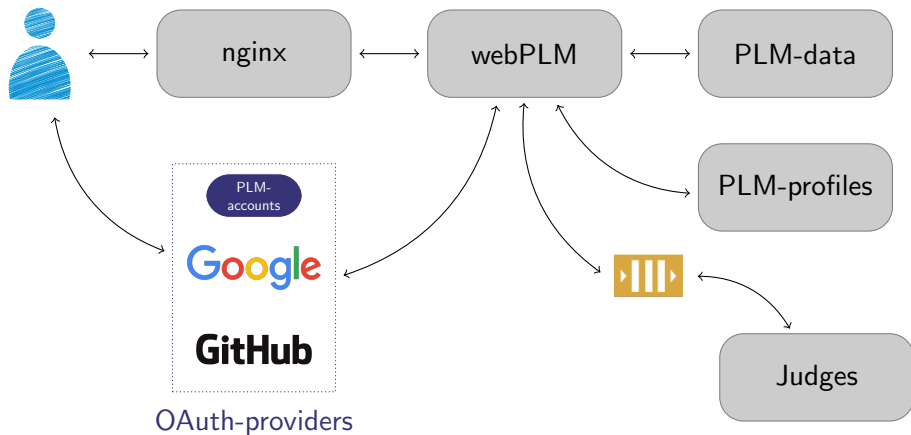
- Challenges
- Extraction of the execution component
- Docker

## 4 Result

## 5 Next steps

# Result

## Current architecture





# Result

Live-session in TELECOM Nancy

- Used in TELECOM Nancy in September 2015
- 30 hours of live testing with 100 students

# Result

Live-session in TELECOM Nancy

- Used in TELECOM Nancy in September 2015
- 30 hours of live testing with 100 students
- Engine is (almost) working fine...
- ... but user experience needs to be improved!

# Result

Live-session in TELECOM Nancy

- Scalability issues:
  - Work well with small exercises
  - Can't cope with workload of larger exercises

# Result

Live-session in TELECOM Nancy

- Scalability issues:
  - Work well with small exercises
  - Can't cope with workload of larger exercises
- No tools for monitoring set up...

# Result

Live-session in TELECOM Nancy

- Scalability issues:
  - Work well with small exercises
  - Can't cope with workload of larger exercises
- No tools for monitoring set up...
- ... so the bottleneck is unknown.

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# Next steps

Refactor the code

- Rushed to release a stable version before September 2015...
- Needed to clean some parts of the code
- Merged local and centralized mode branches

# Next steps

Simplify workflow to adapt the content

- Store most of content inside PLM-engine
- Heavy and error prone workflow
- Need to extract the content from PLM-engine's jar
- Allow to implement an exercise editor



# Next steps

Solve performance issues

- Set up some monitoring tools
- Perform some load testing to identify the bottleneck

# Next steps

- Integrate interns' contributions
- Set up Continuous Deployment
- Support additional programming languages
- Implement a debug mode similar to popular IDEs' ones
- Add features to help teachers to supervise their students
- ...

Thanks for your attention, any questions?